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Complete transmission system with a highly non-linear dispersion shifted photonic crystal fibre as the demultiplexer

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Abstract: A highly non-linear 50 m long photonic crystal fibre with zero-dispersion wavelength at 1552 nm is investigated as a 40 to 10 Gb/s demultiplexer in a complete transmission system. 160 to 10 Gb/s is feasible.

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1. Introduction

Increasing channel rates in communication systems requires fast switches such as a non-linear optical loop mirror (NOLM) [1]. A NOLM usually requires a long non-linear fibre to generate sufficient phase shift in the interferometer, but by using a photonic crystal fibre (PCF) this length may be considerably reduced.

In this paper, we show the characteristics of an only 50 m long highly non-linear PCF in a NOLM in a complete transmission experiment at 40 Gb/s and show its potential for higher bit rates.

2. Principle and experimental set-up

The experimental set-up is shown in Fig. 1. The NOLM contains the PCF with zero dispersion at 1552 nm [2] and

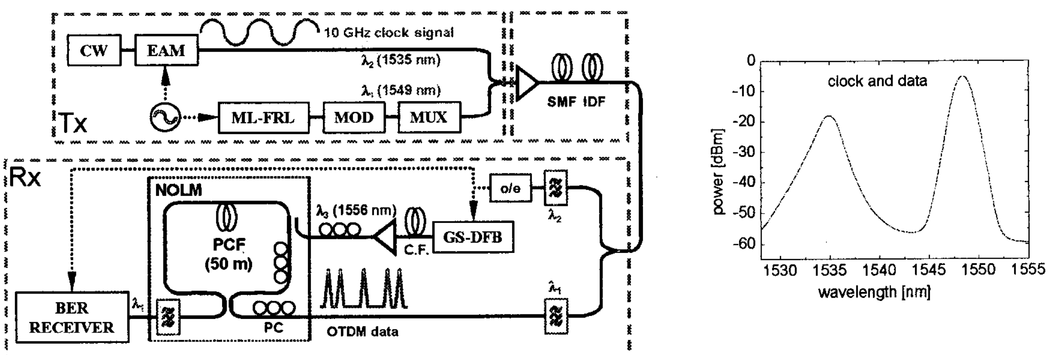

Fig. 1. Schematic set-up

a non-linear coefficient of 18 $W^{-1}km^{-1}$. To synchronise the receiver to the data, a base rate clock signal is transmitted with the data signal. An electroabsorption modulator (EAM) generates the clock at $\lambda_2 \sim 1535$ nm (Fig. 1 right). The o/e-converted transmitted clock drives the control pulse source (gain-switched DFB laser (GS-DFB), FWHM ~ 12 ps, $\lambda_3 \sim 1556$ nm), and triggers the pre-amplified BER receiver. A mode-locked fibre ring laser (ML-FRL) provides the data pulses (FWHM ~ 3 ps, at 10 GHz and $\lambda_1 \sim 1549$ nm. The pulse train is data modulated (MOD) and the 10 Gb/s data is multiplexed to 40 Gb/s (MUX). The signals are transmitted over 25 km SMF and 25 km IDF with zero dispersion at 1549 nm. After transmission the clock and data are separated by filters. The data is switched through the NOLM only when a control pulse is injected due to the optical Kerr effect [3].

3. Characterisations and BER performance

Fig. 2 left shows that more data (at λ_1) is switched through as the control power is increased with a switching

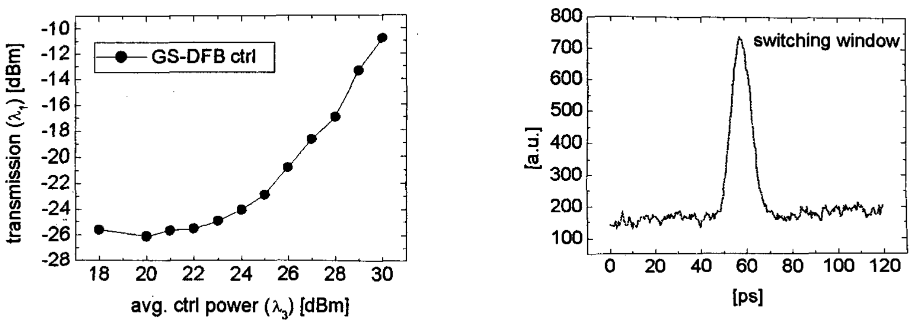

Fig. 2. Switching characteristics of the PCF-based NOLM. Left: Transmitted CW power as function of control power (contrast: 15 dB). Right: Autocorrelation of the induced switching window (width: 9 ps).

contrast of 15 dB. As typical for a NOLM, the switching window is narrower than the control pulse - only 9 ps wide (Fig. 2 right).

Fig. 3 shows the clear and open eye diagrams after transmission. All four demultiplexed channels are error free. The penalties compared to the back-to-back arise from a combination of multiplexing, transmission and demultiplexing, and span from 1.9 dB to 4.8 dB. The different penalties are caused by an imperfect multiplexer.

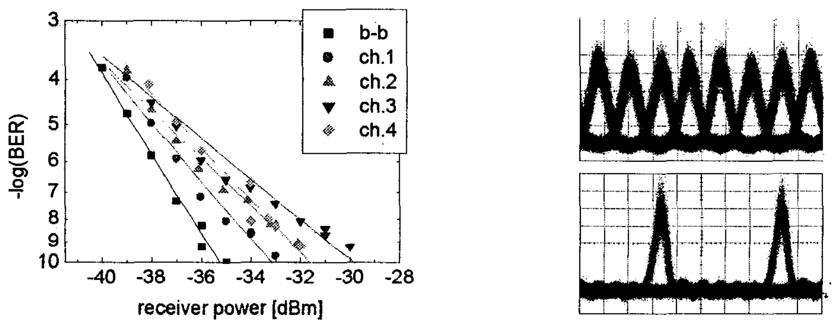

Fig. 3. BER performance. Left: BER curves. Right: 40 Gb/s eye diagram and demuxed 10 Gb/s eye.

The demultiplexing penalty is low, since there is less than 0.1 ps walk-off in the NOLM and a high contrast for switching.

This system operates at 40 Gb/s, but can operate at bit rates as high as 160 Gb/s if narrower control pulses are used as in [4].

4. Conclusion

We have demonstrated an entire transmission system with a PCF-based demultiplexer operating at 40 Gb/s and with potential for 160 Gb/s operation.

5. References

1. M. Nakazawa et al, "1.28 Tbit/s – 70 km OTDM transmission using third- and fourth-order simultaneous dispersion compensation with a phase modulator," Electron. Lett. **36**(24), 2027-2029 (2000).

2. K.P. Hansen et al, "Highly Nonlinear Photonic Crystal Fiber with Zero-Dispersion at 1.55 µm," in Proceedings of OFC'02 (2002), post deadline paper FA9

3. M. Jinno, "Effects of Group Velocity Dispersion on Self/Cross Phase Modulation in a Nonlinear Sagnac Interferometer," J. Lightwave Technol. **10**(8), page 1167-1178 (1992).

4. L.K. Oxenløwe et al, " A photonic crystal fibre used as a 160 to 10 Gb/s demultiplexer," in Proceedings of OECC 2002 (2002), post deadline paper PD-1-4.